short-wave receiver has been built at the Weather Bureau and will soon be in use. The use of the short-wave sets will enable such tests to be carried on whenever desired and without restriction. Experiments are being carried on between Washington and Chicago using both short and long-wave transmissions. Further experiments will be conducted at the central office to determine the ability to register isobars and weather data on printed base maps instead of transmitting an entire map for reception upon plain paper. It is also hoped to speed up the time of reception from 50 minutes to approximately 15 minutes.

Since the first weather map was transmitted in August, several changes have been made in the machine design, to better adapt it to weather-map transmission. Daily tests of reception have shown marked improvement and maps of good quality are now being received. However, as reception conditions are well above the average in this case—the distance between Arlington and the Weather Bureau Office being but a few miles—we must await the results of the not yet thoroughly tested distant transmission, Arlington to Chicago, before we can know the performance of the machines under long-distance conditions.

A description of the operation of the Jenkins system in transmitting the weather map will be of interest. A map is drawn in black ink on a special base. (See Figure 2.) A photographic negative is then made of it, by direct contact printing. This is taken at once to the broadcasting station and placed in the transmitting machine.

The transmitter consists, in brief, of a glass cylinder, about which is wrapped the photographic negative. The cylinder is revolved at a constant speed by an electric motor. Within the cylinder is a small but powerful electric light. Outside of the cylinder is a light-sensitive photo-electric cell which is arranged so as to move along in front of the length of the cylinder at the rate of one-fiftieth of an inch for one complete revolution of the cylinder. This cell has a very small aperture and the light from within the glass cylinder passes through and affects the sensitivity and electrical conductivity of the cell. The electric light within the cylinder advances with the cell so as to be always opposite the aperture.

As the black and white portions of the film (the whites being transparent and the darks opaque) rotate before the aperture of the cell, the light passing through from within is intermittently cut on and off and the conductivity of the cell is varied accordingly. But as the cell is advancing along the cylinder from one end to the other at the rate of one-fiftieth of an inch to each revolution and the diameter of the aperture is the same, it will be seen that the same transparent place on the film never passes before the cell opening more than once. As the light is broken up into impulses of various durations by the white lines of the film, it causes corresponding variations in the electrical resistance of the cell. These resistance changes cause sharp fluctuations in the flow of current through the cell.

In order that this very weak current may be strengthened so that it will operate the relays of the powerful radio set, it must be passed through a number of alternating current transformers and amplifying electron tubes. A pulsating direct current through the cell is obtained by breaking up the light waves by means of a chopper wheel rotating in front of the electric light within the cylinder. This pulsating current can be transformed into alternating current so as to pass through any number of amplifying units necessary. The signals sent out by the radio station are similar to code signals except that they are a meaningless jumble of dots and dashes which are confusing to the uninitiated radio operator.

These may be received by any type of radio set capable of tuning to the wave lengths used and, after being suitably amplified, are passed to the map reproducer. A sheet of white paper is wrapped about a rotating cylinder of the same size as the one on the transmitter. Both cylinders operate as nearly as possible at the same speed and, as the radio impulses come in, a magnetic pen traces lines on the rotating paper to correspond with the transparent whites of the negative. The pen advances at the same rate as the electric cell before the rotating cylinder and the map picture is reproduced by a large number of fine lines marked in their proper positions and drawn in a very flat spiral around the paper on the cylinder. (See Figure 3.)

If the speeds of the two machines differ, the picture will be more or less distorted. Constant and equal speed of both machines is mechanically impracticable; hence it has been found necessary to synchronize the cylinders at each revolution. A special synchronizing master signal is transmitted at the end of each revolution of the sending machine, to hold the receiving cylinder from revolving until the end of this signal comes. In this way each new revolution begins in synchronism with that of the transmitter. The hesitation at the end of each revolution is very slight, but it is sufficient to keep any number of receiving machines in perfect step with the transmitting machine.

A photographic recorder is not used as such a machine is complicated and requires the use of dark rooms, careful handling of sensitive films, and the development and printing of the completed picture, all of which consume valuable time. The receiver now used instantly reproduces with ink and, when the last signal impulse is recorded, the map is complete.

HORIZONTAL GROUND DAY VISIBILITY AT ELLENDALE, N. DAK.

551.591 (784)

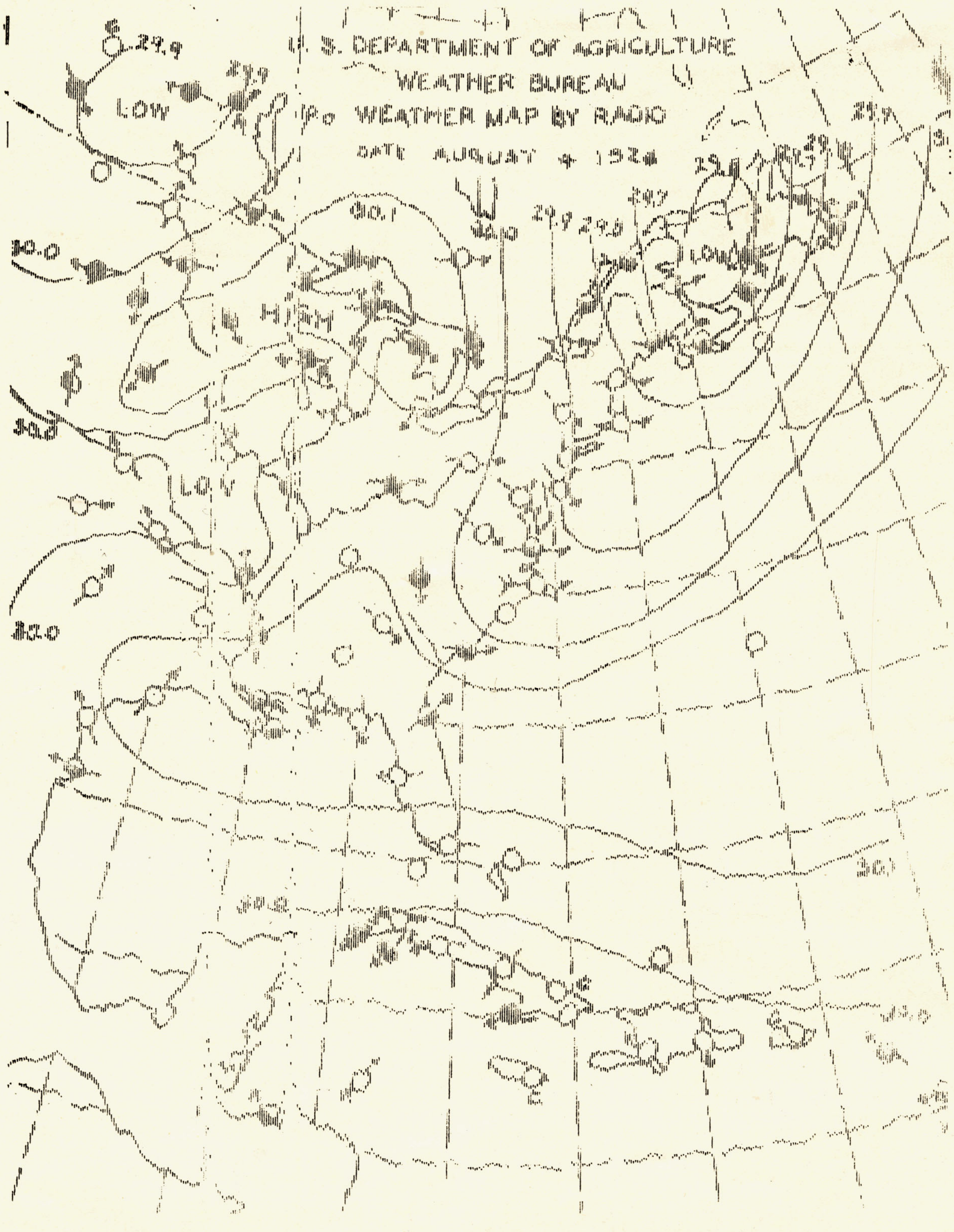
By LESLIE A. WARREN

[Weather Bureau Office, Ellendale, N. Dak.]

This paper is based on one year's observations at Ellendale, July 1, 1925, to June 30, 1926. Observations were made five and six times daily, at sunrise, 7 a. m., 10 a. m., 12:30 p. m., 3 p. m., 5:30 p. m., 8 p. m., and sunset. The sunrise, 7 a. m., 5:30 p. m., 8 p. m., and sunset observations were taken during part of the year only and not during the remainder, depending upon the time of sunrise and sunset. In addition to the record of visibility, certain other meteorological elements seeming to have more or less direct influence or effect on visibility were observed and recorded.

This paper confines itself principally to tabulating visibility frequencies and percentages of occurrence as they relate to the several other meteorological elements.

Unfortunately the topography about Ellendale is such that from our observation field east of town the only direction in which objects at greater distances than 9,000 meters can be seen is toward the southeast. The view



First experimental Weather map transmitted from radio station Arlington Va. and received at Weather Bureau Office, Washington, D.C. on August 18, 1926

E B Calvert

Fig. 1.

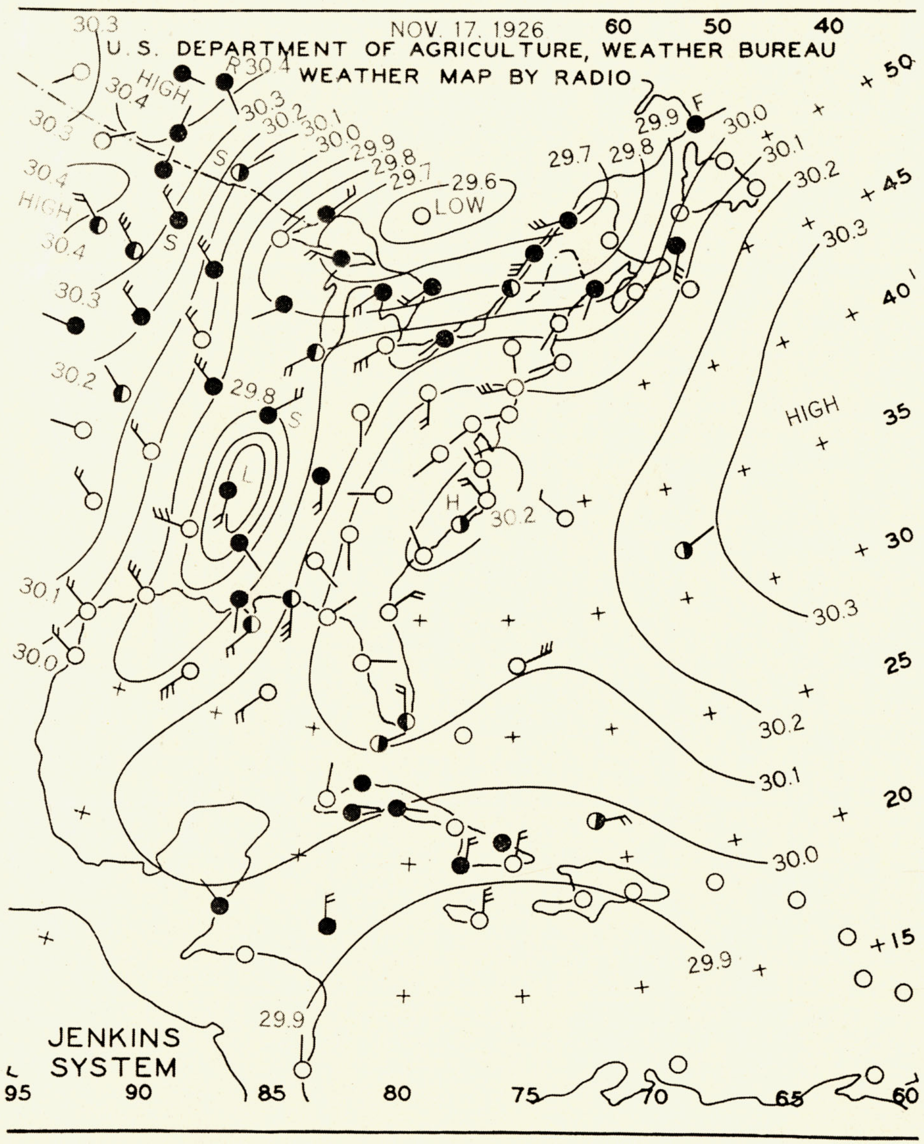


FIG. 2.—Special weather map of November 17, 1926, from which photographic negative was made for radio transmission

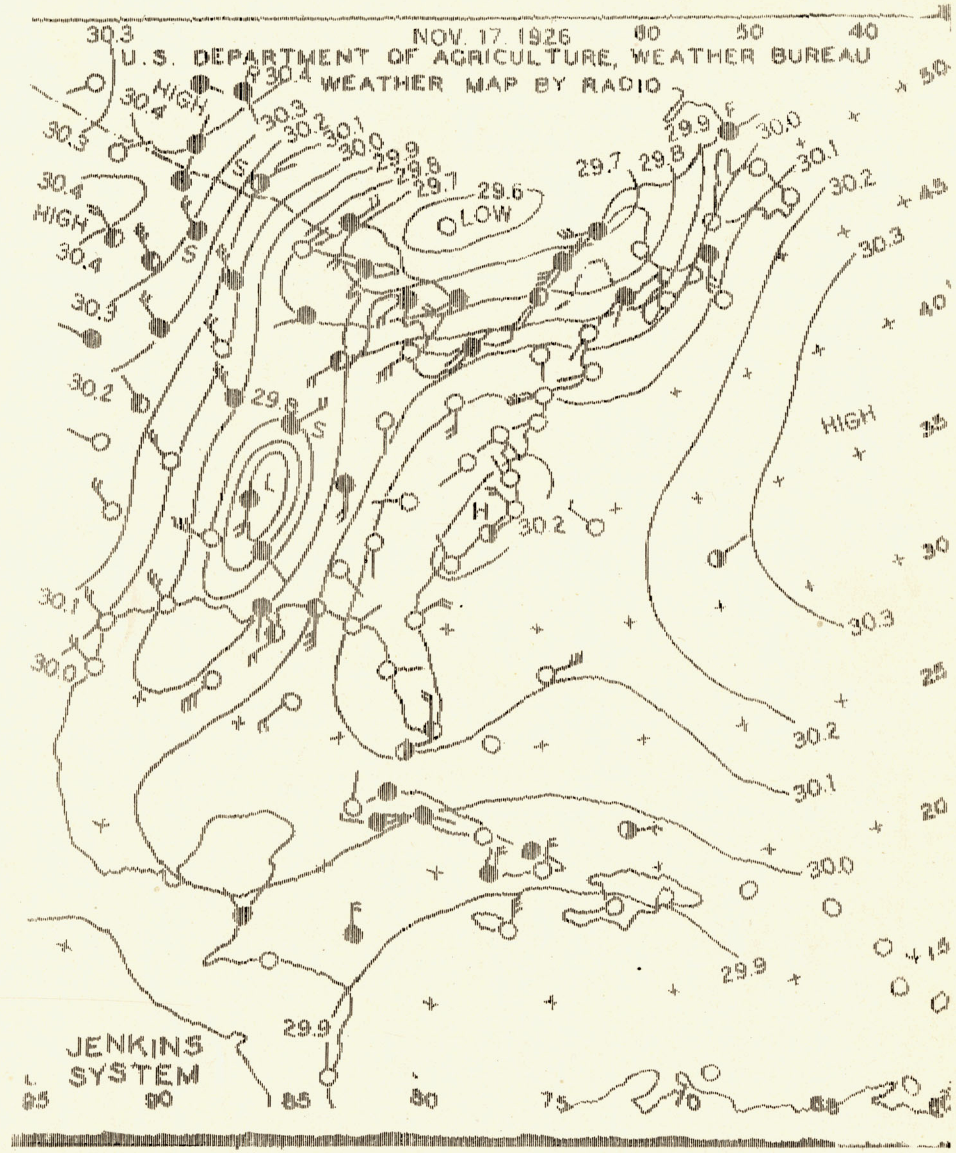


FIG. 3.—Map of November 17, 1926, as received at the Weather Bureau Office, Washington, from Station NAA, Arlington, Va.

in that direction is unbroken. From Ellendale a view toward both east and west is available, hence the evening observation was made in these directions, from the town. Determination of mean visibility is considered best when observations are made toward north and south, but these are impracticable in our case. However, we make no observations directly toward the sun.

The visibility scale in accordance with which these observations were made is the International Visibility Scale as it was before three recent changes were made in it, and during the period of the observations. For the purposes of this paper the old scale is quite satisfactory, and is given herewith.

International Visibility Scale

Descriptive term	Prominent objects not visible at—	
	Meters	Feet
Dense fog	50	160
Very bad	200	650
Bad	500	1,600
Very poor	1,000	3,300
Poor	2,000	6,600
Indifferent	4,000	13,100
Fair	7,000	23,000
Good	12,000	39,400
Very good	30,000	98,400
Excellent, prominent objects visible beyond	30,000	98,400

Table 1 summarizes the average seasonal and annual percentage frequencies of visibility for all the observations made during the year. Considering only those that were made daily throughout the year (10 a. m., 12:30 p. m., and 3 p. m.) as indicative of the daily averages, we find that autumn shows a greater frequency for the lesser visibilities, while summer shows a tendency toward better visibilities. The percentage frequency of visibility less than 7,000 meters is markedly lower for the afternoon observations than for those either morning or evening. Hence, we may assume that generally the best visibility occurs during the summer months and in the afternoon.

The percentage of occurrence of various visibilities according to surface wind direction is shown in Table 2. The greatest percentage of observations was made with NW. surface winds and the least with ESE. winds. Visibilities of less than 2,000 meters were not observed with either of these winds. The highest percentage of "very good" visibility occurred with west wind. On the whole it appears that we may expect better visibility with surface winds in the northwest quadrant, and poorer visibility with winds in the northeast.

Visibility frequencies with prevailing wind directions aloft through the first kilometer are given in Table 3. The greatest number of observations occurred with NNW. winds in this layer and the least with E. and ESE. winds prevailing. The best visibility may be expected with WNW. wind prevailing through this first kilometer and the poorest with ESE. wind.

Study of Table 4, in which visibility is compared with surface wind of velocity greater than and less than 5.4 m. p. s., shows that the frequencies of the better visibilities are nearly alike for both classes of wind velocity. The lesser visibilities seem more likely to occur with light surface winds than with strong.

Whether or not the sun is obscured by clouds apparently has but little effect on horizontal visibility; therefore this subject will not be discussed here.

We shall now consider visibility in connection with the meteorological elements of more vital concern to air navigation. The safety of flying varies considerably with the variations of low cloud, fog, and precipitation.

The existence of low clouds between 500 meters and 2,000 meters altitude appears to have no bad effect on visibility; but fog and, under certain conditions, cloud below 500 meters do affect visibility considerably. In Table 5, the first line shows what percentages of the grand total of observations were made when the sky was 0.5 or more clouded, for the different visibilities. The second line shows the percentages of occurrence of each visibility, in the observations made when the sky was covered 0.5 or more. We find that but 57 per cent of the cases indicate visibility less than 7,000 meters and but 22 per cent less than 4,000.

Table 6 shows visibility frequencies and percentages of occurrence with low clouds between 250 and 1,000 meters altitude. Only 100 observations were made under these conditions, out of a total of 730. Of cases of good visibility (12,000 m.), a very slightly higher percentage occurs in the afternoon, while the fair visibilities (7,000 m.) are considerably more frequent in the morning. No cases of less than 1,000 m. occurred in the afternoon, and but 3 in the morning.

In considering the visibility with clouds and fog lower than 250 meters, only the number of cases is given in Table 7. But 31 observations were made under these conditions. We find, of course, the best visibility with low clouds, the next best with light fog and the poorest with dense fog.

A few conclusions regarding other of the elements, for which tables have not been prepared, have been drawn from a study of the visibility record, as follows:

Days with thermal convection are more likely to give good visibility than those without. Convection is not, however, to be considered as an important determining factor in the causes of the better degrees of visibility.

On the whole it appears that we have fair or good visibility more often when we are under the influence of the eastern half of high pressure areas of the Alberta or North Pacific types than under any other pressure condition.

We find that better visibility occurs on days with low average relative humidity, except for the early morning observation; a number of good and very good visibilities were recorded with comparatively high humidity at the first morning observation.

TABLE 1.—*Average seasonal and annual frequency of visibility less than 12,000, 7,000, 4,000, 2,000, 1,000, 500, and 200 meters*

7 A. M.

Visibility less than—		Spring	Summer	Autumn	Winter	Annual
Meters	*Feet*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
200	650	0	1	5	0	2
500	1,600	0	3	5	0	2
1,000	3,300	0	3	5	8	4
2,000	6,600	0	4	5	17	6
4,000	13,100	5	12	15	17	12
7,000	23,000	37	47	59	58	50
12,000	39,400	89	91	100	100	95

SUNRISE

200	650	----------	----------	2	3	2
500	1,600	----------	----------	8	4	6
1,000	3,300	----------	----------	10	9	10
2,000	6,600	----------	----------	16	14	15
4,000	13,100	----------	----------	16	22	19
7,000	23,000	----------	----------	76	73	74
12,000	39,400	----------	----------	100	100	100

TABLE 1.—*Average seasonal and annual frequency of visibility less than 12,000, 7,000, 4,000, 2,000 1,000, 500, and 200 meters*—Con.

10 A. M.

Visibility less than—		Spring	Summer	Autumn	Winter	Annual
Meters	*Feet*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
200	650	0	0	1	0	[1]0
500	1,600	0	0	3	0	1
1,000	3,300	0	0	4	6	2
2,000	6,600	1	2	14	8	6
4,000	13,100	10	8	22	16	14
7,000	23,000	33	36	46	52	42
12,000	39,400	93	100	95	99	97

12:30 P. M.

200	650	0	0	0	0	0
500	1,600	0	0	0	0	0
1,000	3,300	0	0	2	1	1
2,000	6,600	0	0	7	4	3
4,000	13,100	5	4	9	12	8
7,000	23,000	29	30	26	36	30
12,000	39,400	93	99	90	91	93

3 P. M.

200	650	0	0	0	0	0
500	1,600	0	0	0	0	0
1,000	3,300	0	0	0	1	[1]0
2,000	6,600	2	0	4	6	3
4,000	13,100	8	4	9	7	7
7,000	23,000	29	23	31	26	27
12,000	39,400	82	78	77	71	77

[1] Less than 0.5 per cent.

TABLE 1.—*Average seasonal and annual frequency of visibility less than 12,000, 7,000, 4,000, 2,000, 1,000, 500, and 200 meters*—Con.

5:30 P. M.

Visibility less than—		Spring	Summer	Autumn	Winter	Annual
Meters	*Feet*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
200	650	0	0	0	---------	0
500	1,600	0	0	2	---------	1
1,000	3,300	0	0	5	---------	2
2,000	6,600	0	0	7	---------	2
4,000	13,100	7	4	7	---------	6
7,000	23,000	31	24	23	---------	26
12,000	39,400	86	95	84	---------	88

SUNSET

200	650	0	0	0	0	0
500	1,600	0	0	0	0	0
1,000	3,300	0	0	0	0	0
2,000	6,600	0	0	0	0	0
4,000	13,100	6	7	6	7	6
7,000	23,000	29	62	32	40	41
12,000	39,400	93	100	100	96	97

8 P. M.

200	650	0	0	---------	---------	0
500	1,600	0	0	---------	---------	0
1,000	3,300	0	0	---------	---------	0
2,000	6,600	0	0	---------	---------	0
4,000	13,100	0	2	---------	---------	1
7,000	23,000	10	40	---------	---------	25
12,000	39,400	90	98	---------	---------	94

TABLE 2.—*Visibility with surface wind direction*

Surface wind direction			N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
Observations with visibility	Meters	Feet	Percentage of occurrence															
			11	5	8	3	2+	2−	5	3	11	5	6	3	5	5	17	10
Very bad	200	650	0	0	0	0	0	0	0	0	[1]0	1	1	2	0	0	.6	0
Bad	500	1,600	.5	0	1	0	2	0	0	0	1	4	0	2	0	0	0	0
Very poor	1,000	3,300	1	1	2	2	4	0	0	0	1	4	1	0	0	0	1	0
Poor	2,000	6,600	3	3	**4**	2	2	**0**	2	2	3	**0**	2	**0**	1	**0**	2	3
Indifferent	4,000	13,100	3	6	5	6	4	3	8	9	8	**10**	4	2	**0**	5	3	6
Fair	7,000	23,000	23	28	31	36	38	30	**42**	31	40	29	**17**	**17**	25	24	22	25
Good	12,000	39,400	62	53	50	52	46	61	**44**	51	**44**	46	**67**	62	55	59	62	53
Very good	30,000	98,400	8	9	8	**2**	6	6	4	6	3	7	9	15	**18**	12	11	13

[1] Less than 0.5%.

NOTE.—The extremes under "Poor" to "Very good" visibility are printed in boldface type.

TABLE 3.—*Visibility frequencies with prevailing wind direction, aloft through first kilometer*

Visibility less than—		N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
		Per cent															
Meters	*Feet*																
200	650	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	0
500	1,600	0	0	0	0	0	7	0	0	2	0	0	4	0	0	1	0
1,000	3,300	0	3	0	0	7	7	0	0	4	2	2	4	0	0	1	0
2,000	6,600	1	9	0	4	13	7	6	11	6	2	5	4	0	0	2	2
4,000	13,100	4	9	8	7	20	13	12	28	14	8	5	4	3	4	3	5
7,000	23,000	37	41	25	37	40	60	53	44	55	42	45	42	22	34	30	37
12,000	39,400	86	85	88	93	93	93	94	95	98	82	91	77	77	77	85	82
Total number of observations with		91	34	24	27	15	15	17	18	49	50	44	26	37	47	87	97

TABLE 4.—*Visibility with surface wind velocity*

Visibility	5.4 m. p. s. and less: Less than—	5.4 m. p. s. and less: Percentage frequency	5.4 m. p. s. and less: Per cent of occurrence	More than 5.4 m. p. s.: Percentage frequency	More than 5.4 m. p. s.: Per cent of occurrence
	Miles				
Very bad	200	1	1	[1]0	[1]0
Bad	500	2	1	[1]0	[1]0
Very poor	1,000	3	1	1	1
Poor	2,000	5	2	4	3
Indifferent	4,000	9	4	10	6
Fair	7,000	37	28	37	27
Good	12,000	92	55	91	54
Very good	30,000	100	9	100	9
No. of observations, 913				No. of observations, 1,074	

[1] Less than 0.5 per cent.

TABLE 5.—*Visibility with 0.5 or more of sky obscured by low clouds*

	Visibility: Very bad	Bad	Very poor	Poor	Indifferent	Fair	Good	Very good
Less than (meters)	200	500	1,000	2,000	4,000	7,000	12,000	30,000
Per cent of occurrence	1	2	3	6	10	35	38	5
Percentage frequency	1	3	6	12	22	57	95	100

TABLE 6.—*Visibility with low clouds between 250 m. and 1,000 m. altitude*

[From a total of 730 observations]

Visibility less than—		A. M.: Number of observations	A. M.: Percentage frequency	P. M.: Number of observations	P. M.: Percentage frequency
Meters	*Feet*				
200	650	0	0	0	0
500	1,600	1	2	0	0
1,000	3,300	2	5	0	0
2,000	6,600	3	16	4	9
4,000	13,100	7	24	7	25
7,000	23,000	31	80	17	62
12,000	39,400	9	96	17	100
30,000	98,400	2	100	0	100

TABLE 7.—*Visibility with clouds and fog lower than 250 m.*

Visibility	Meters	Feet	A. M. Number of observations with—: Light fog	A. M.: Dense fog	A. M.: Low clouds	P. M. Number of observations with—: Light fog	P. M.: Dense fog	P. M.: Low clouds
Very bad	200	650	0	3	0	0	0	0
Bad	500	1,600	0	5	0	0	0	0
Very poor	1,000	3,300	3	0	0	2	0	2
Poor	2,000	6,600	2	0	1	1	0	0
Indifferent	4,000	13,100	0	0	6	0	0	0
Fair	7,000	23,000	0	0	5	0	0	1
Good	12,000	39,400	0	0	0	0	0	0

A GRAPHIC AND TABULAR AID TO INTERPRETING CORRELATION COEFFICIENTS

551.501

By J. F. VOORHEES

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A graph and a table are presented herewith, which have been found helpful in correlation studies, because through the use of either of them one may see at a glance what a given value for r is worth for forecasting purposes (*1*).

Suppose we have the value $r = \pm .60$ for a given set of data. Applying the formula $y' = bx - a$, where x is the independent variable, and where $b = \frac{n(\Sigma Xy) - (\Sigma X)(\Sigma y)}{n(\Sigma X^2) - (\Sigma X)^2}$ and $a = \frac{\Sigma y - b\Sigma X}{n}$, (*2*) we obtain the values that y would have if x were the only independent variable. If we now compute the σ of the residuals $(y - y')$ it will be

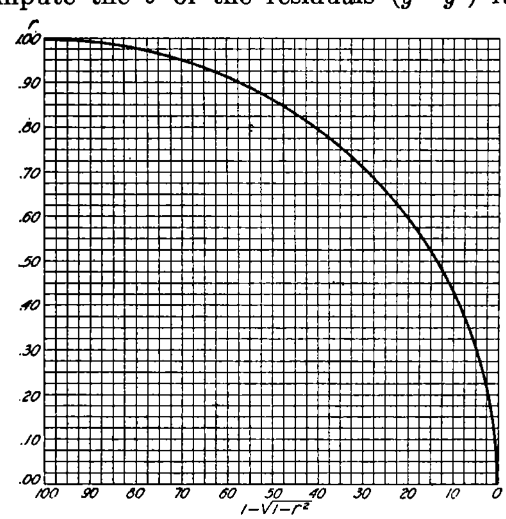

FIG. 1.—Showing value of $1-\sqrt{1-r^2}$, which equals the per cent by which the $\sigma\ (y-y')$ is less than σy, for values of r from 0 to 1

found to be 80% of the σ of y. That is, when $r = \pm .60$, $\frac{\sigma\,(y-y')}{\sigma y} = 80\%$ of the σ of y, or the $\sigma\ (y - y')$ is 20% less than the σy. But, $\frac{\sigma\,(y-y')}{\sigma y} = \sqrt{1-r^2}$, and $1 - \frac{\sigma\,(y-y')}{\sigma y} = 1 - 1\sqrt{1-r^2}$. (*3*)

Plotting the values of $1-\sqrt{1-r^2}$ against the values of r, we get the curve shown in the figure, which is an arc of a circle.

The table may be obtained from the graph or calculated by the formula, % reduction of $\sigma = 1 - \sqrt{1-r^2}$, and represents the percentage by which the $\sigma\ (y - y')$ is less than the σy, for all values of r from 0 to 1.00.

TABLE 1.—*Value of $1-\sqrt{1-r^2}$, which equals the per cent by which $\sigma\ (y-y')$ is less than σy, for values of r from 0 to 1.*

r	$1-\sqrt{1-r^2}$	r	$1-\sqrt{1-r^2}$	r	$1-\sqrt{1-r^2}$	r	$1-\sqrt{1-r^2}$
100	100	75	34	50	13	25	3
99	86	74	33	49	13	24	3
98	80	73	32	48	12	23	3
97	76	72	31	47	12	22	2
96	72	71	30	46	11	21	2
95	69	70	29	45	11	20	2
94	66	69	28	44	10	19	2
93	63	68	27	43	10	18	2
92	61	67	26	42	9	17	2
91	59	66	25	41	9	16	1
90	56	65	24	40	8	15	1
89	55	64	23	39	8	14	1
88	53	63	22	38	8	13	1
87	51	62	22	37	7	12	1
86	49	61	21	36	7	11	1
85	47	60	20	35	6	10	1
84	46	59	20	34	6	9	0
83	45	58	19	33	6	8	0
82	43	57	18	32	5	7	0
81	41	56	17	31	5	6	0
80	40	55	16	30	5	5	0
79	39	54	16	29	4	4	0
78	38	53	15	28	4	3	0
77	36	52	15	27	4	2	0
76	35	51	14	26	3	1	0

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